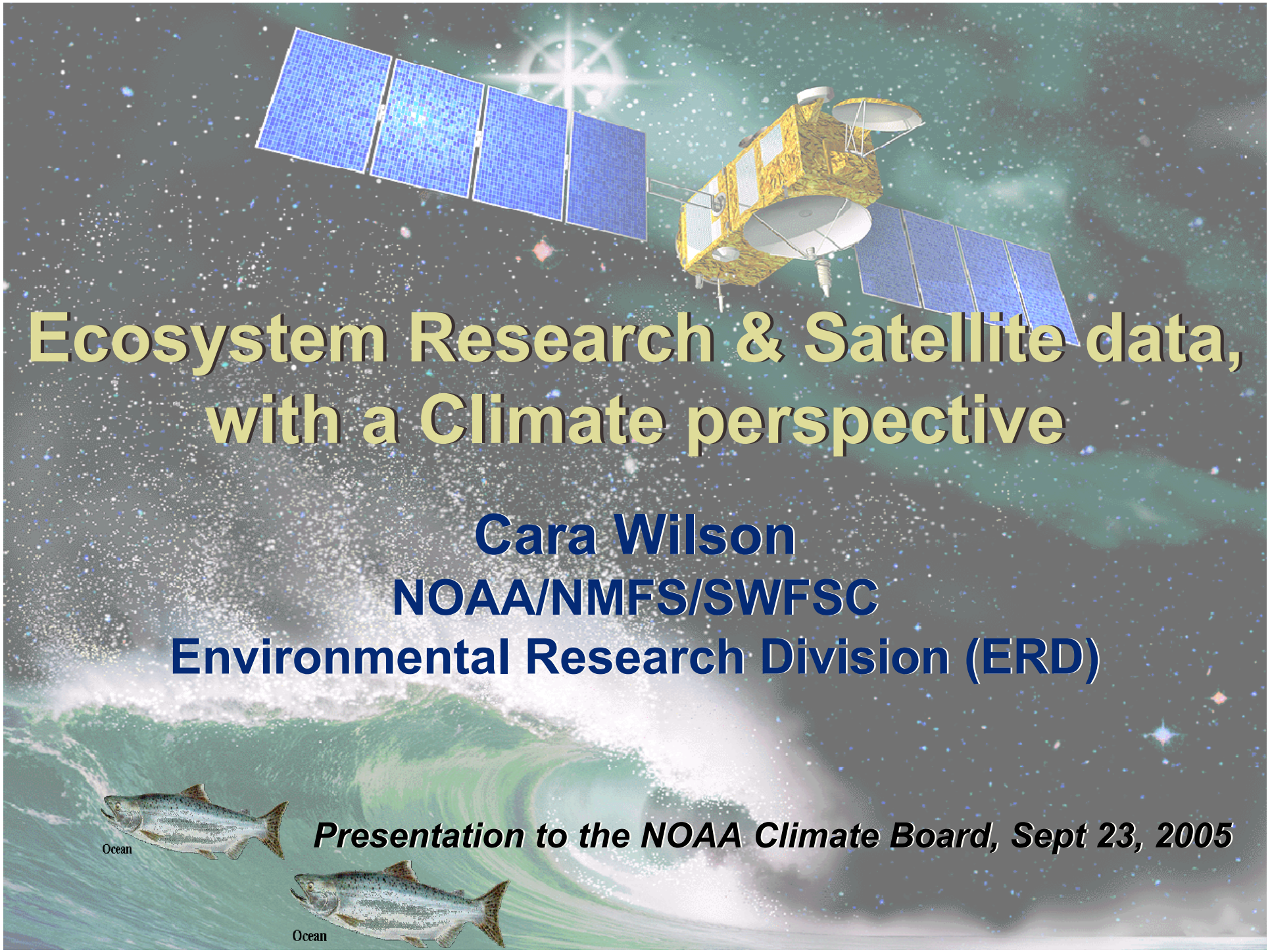


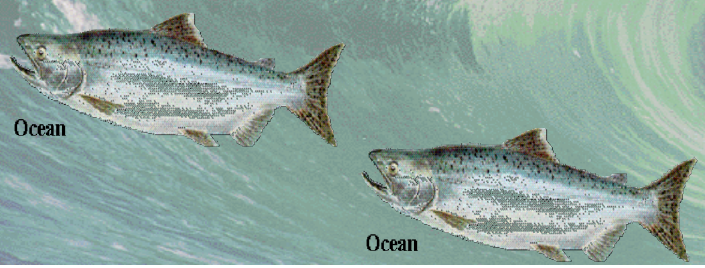
Ecosystem Research & Satellite data, with a Climate perspective

Cara Wilson
NOAA/NMFS/SWFSC
Environmental Research Division (ERD)

Presentation to the NOAA Climate Board, Sept 23, 2005

Outline

- **Part I -**
  Ecosystem Research and satellite data
- **Part II -**
  Climate Research and satellite data

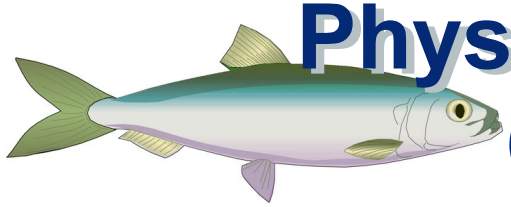


Ultimate Ecosystem

from presentation by Jack Dunnigan, Ecosystem Goal Lead

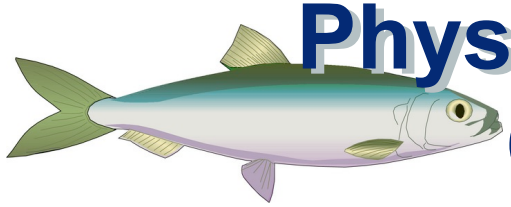
Ultimate Ecosystem

Modified from presentation by Jack Dunnigan, Ecosystem Goal Lead



Physical Features Important to Oceanic Ecosystems

- Ocean fronts and boundaries
- Mesoscale circulation patterns: eddies, meanders, loops
- River plumes
- Convergence zones
- Subsurface thermal structure: MLD, thermocline
- Ocean surface winds
- Ocean currents
- Wave heights



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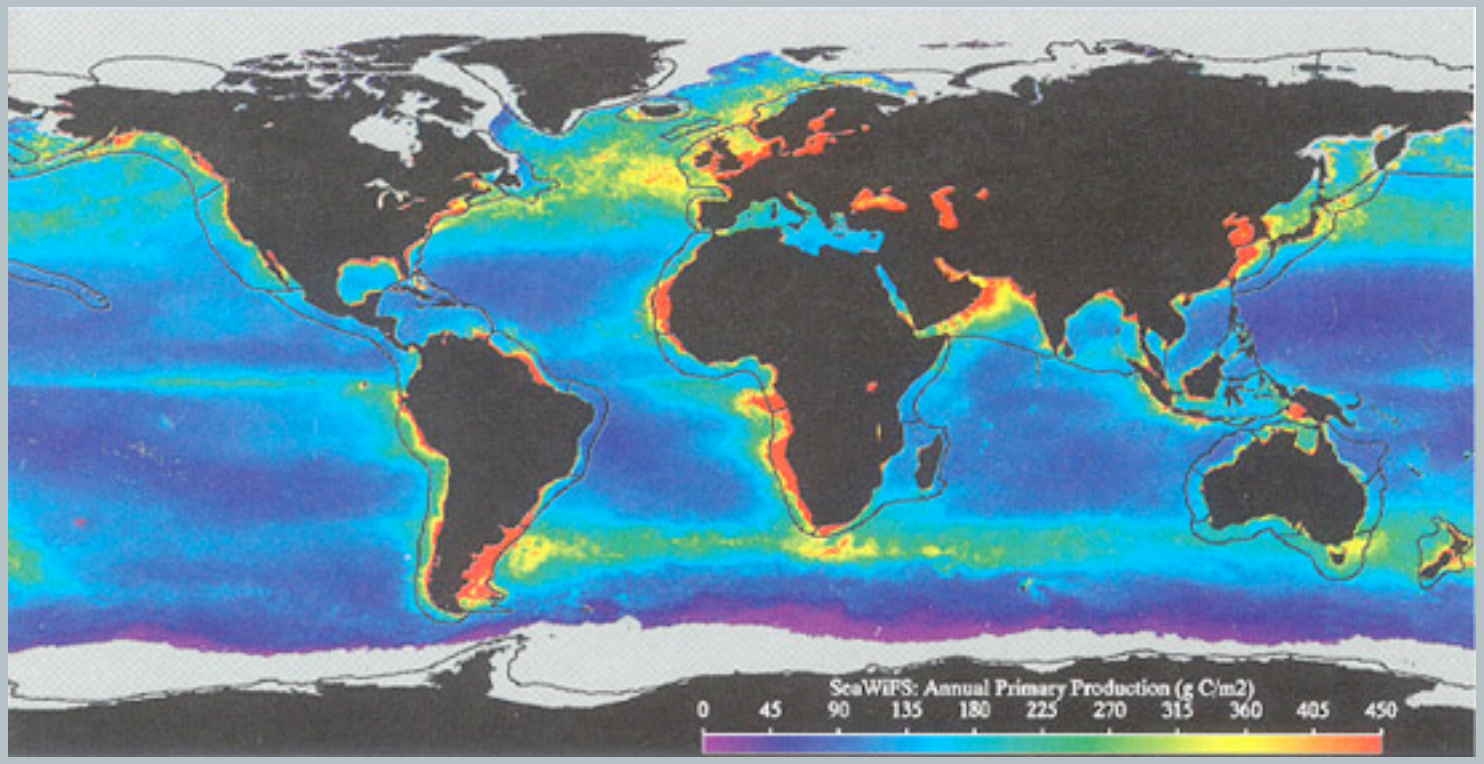
All of these ocean features can be measured, detected, or inferred by satellite data

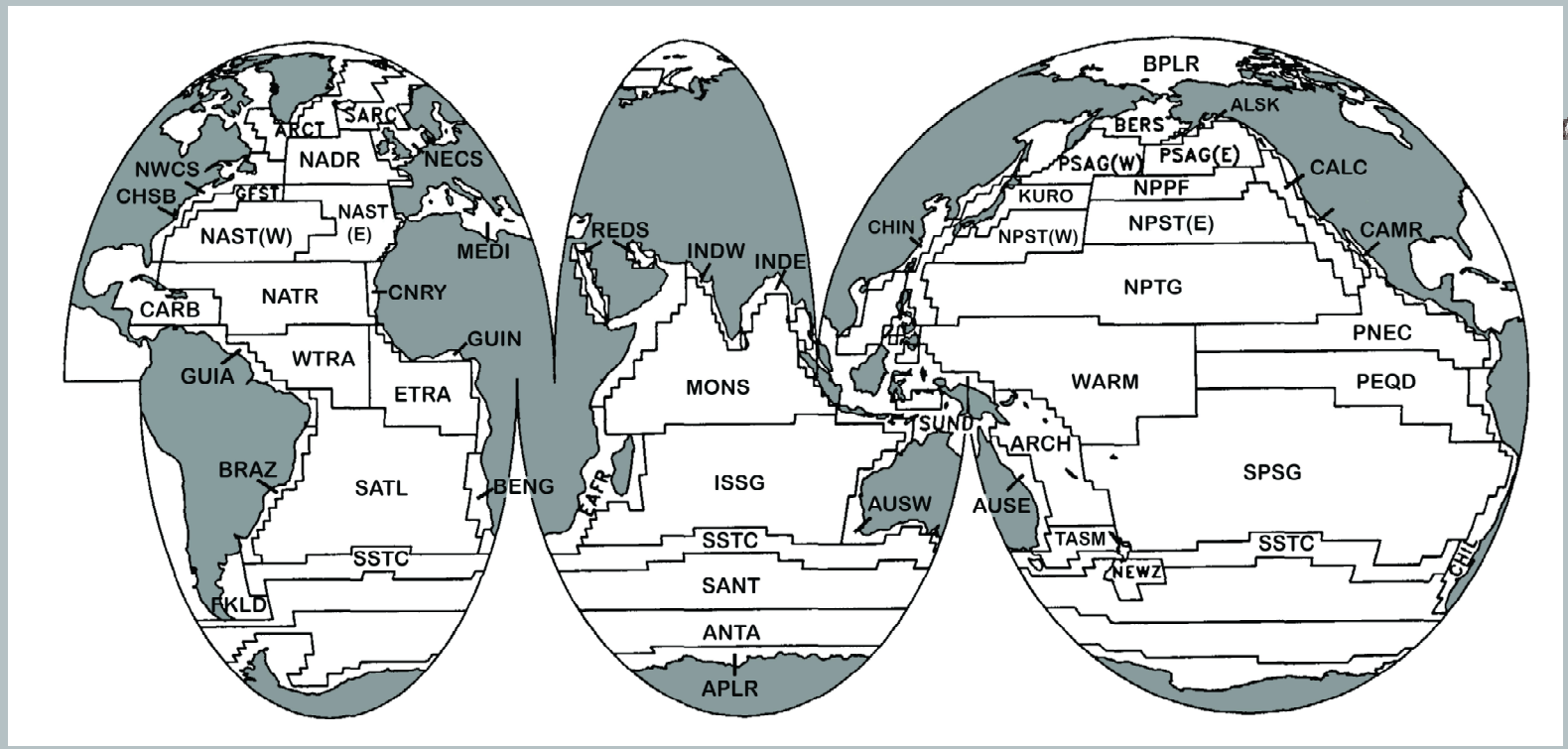
Large Marine Ecosystems



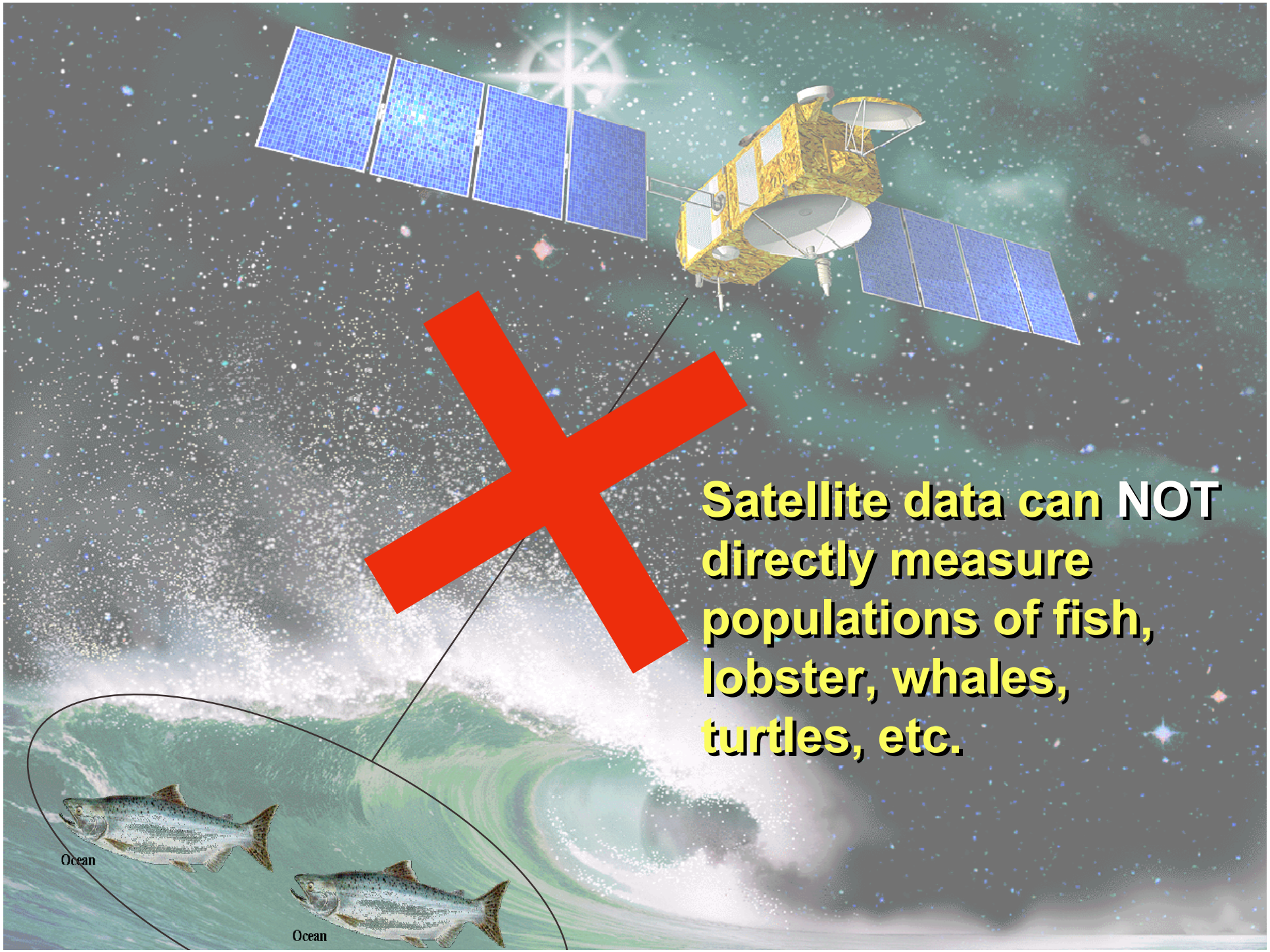
Average satellite-derived Primary Productivity and the outlines of the 64 defined Large Marine Ecosystems (LMEs)

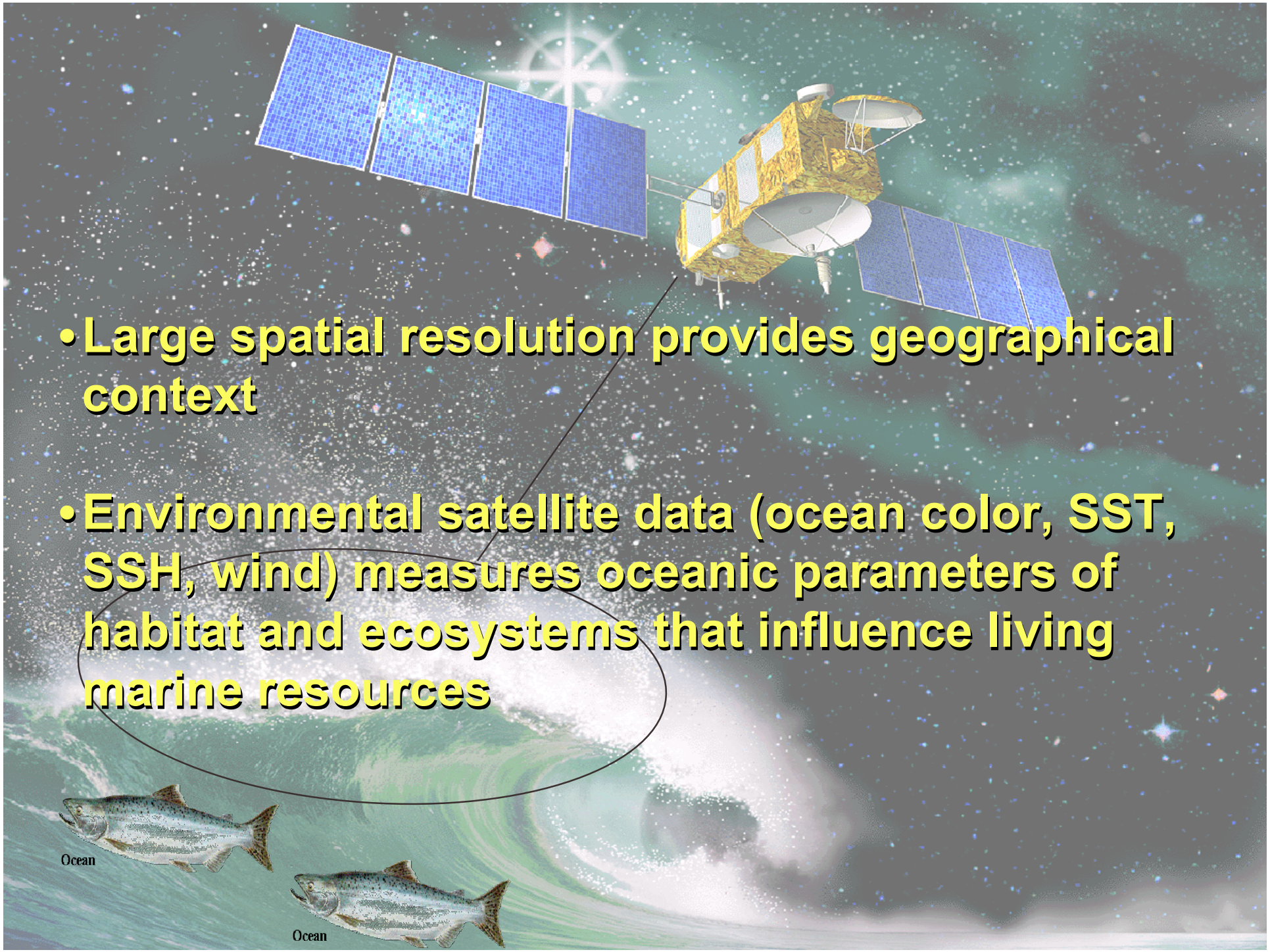
www.wdc.uri.edu/lme

Biogeographical Provinces

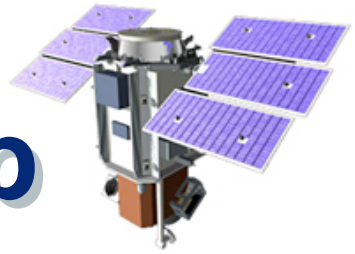


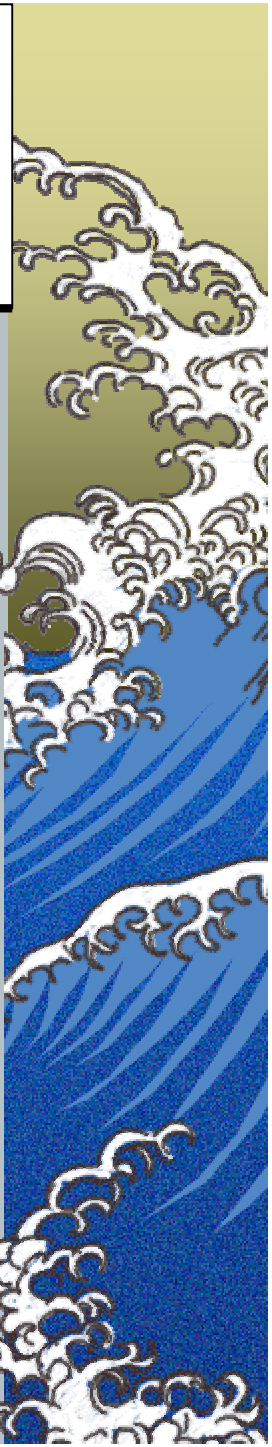
From Longhurst, 1996
Derived from analysis of CZCS satellite chlorophyll data

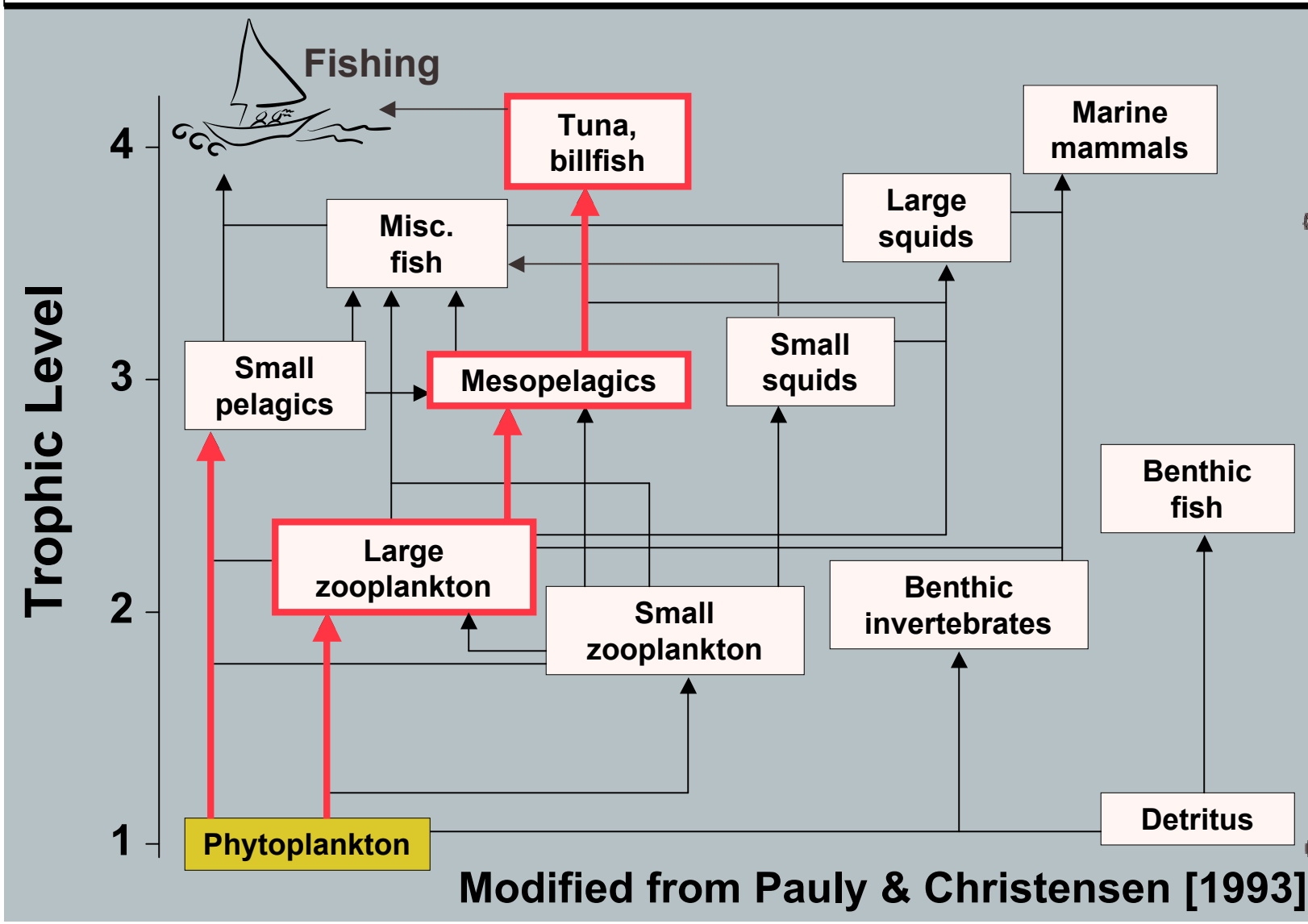

Satellite data can NOT directly measure populations of fish, lobster, whales, turtles, etc.
Ocean
Ocean


• Large spatial resolution provides geographical context
• Environmental satellite data (ocean color, SST, SSH, wind) measures oceanic parameters of habitat and ecosystems that influence living marine resources
Ocean
Ocean

Oceanic Food Web

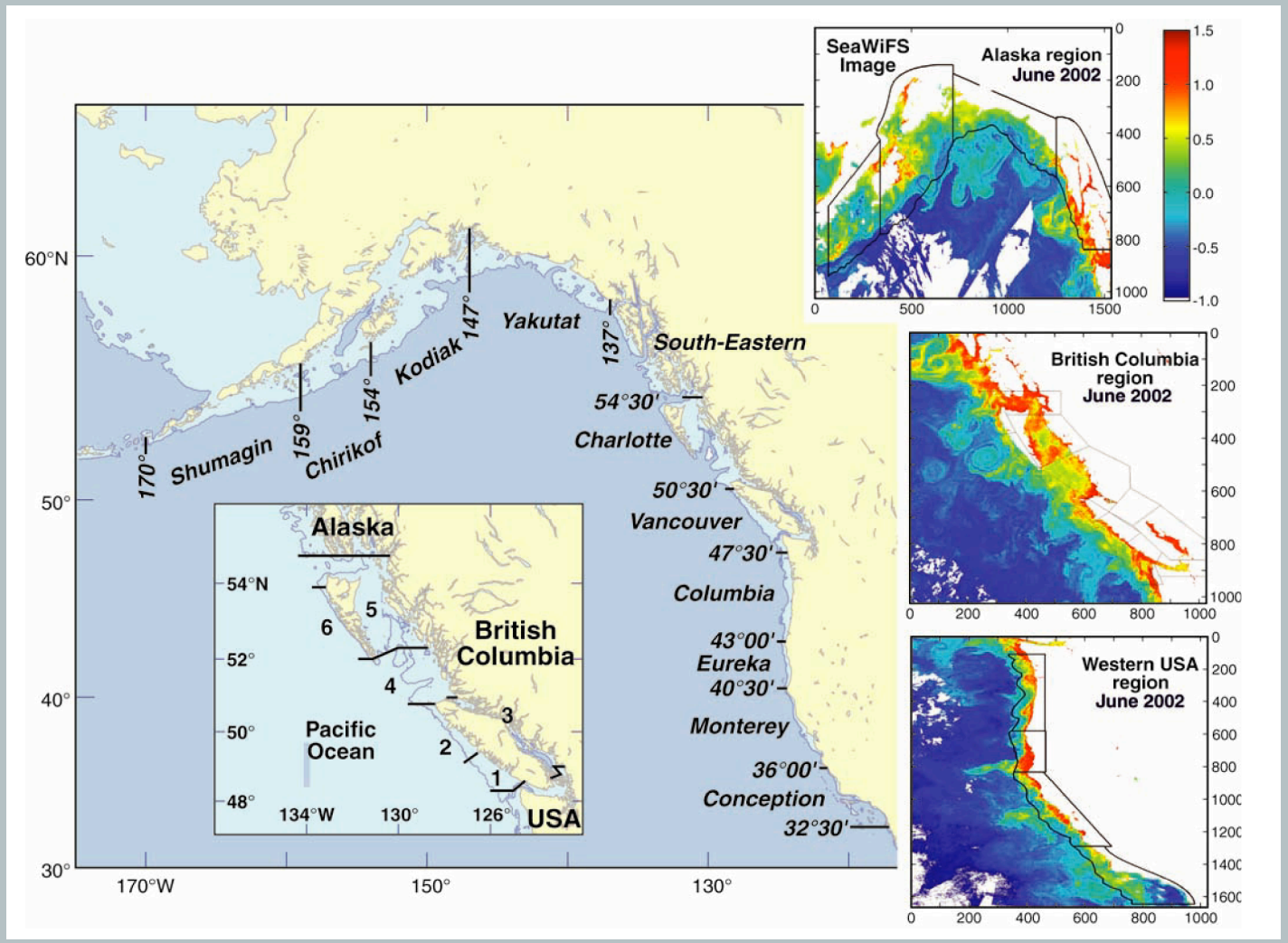






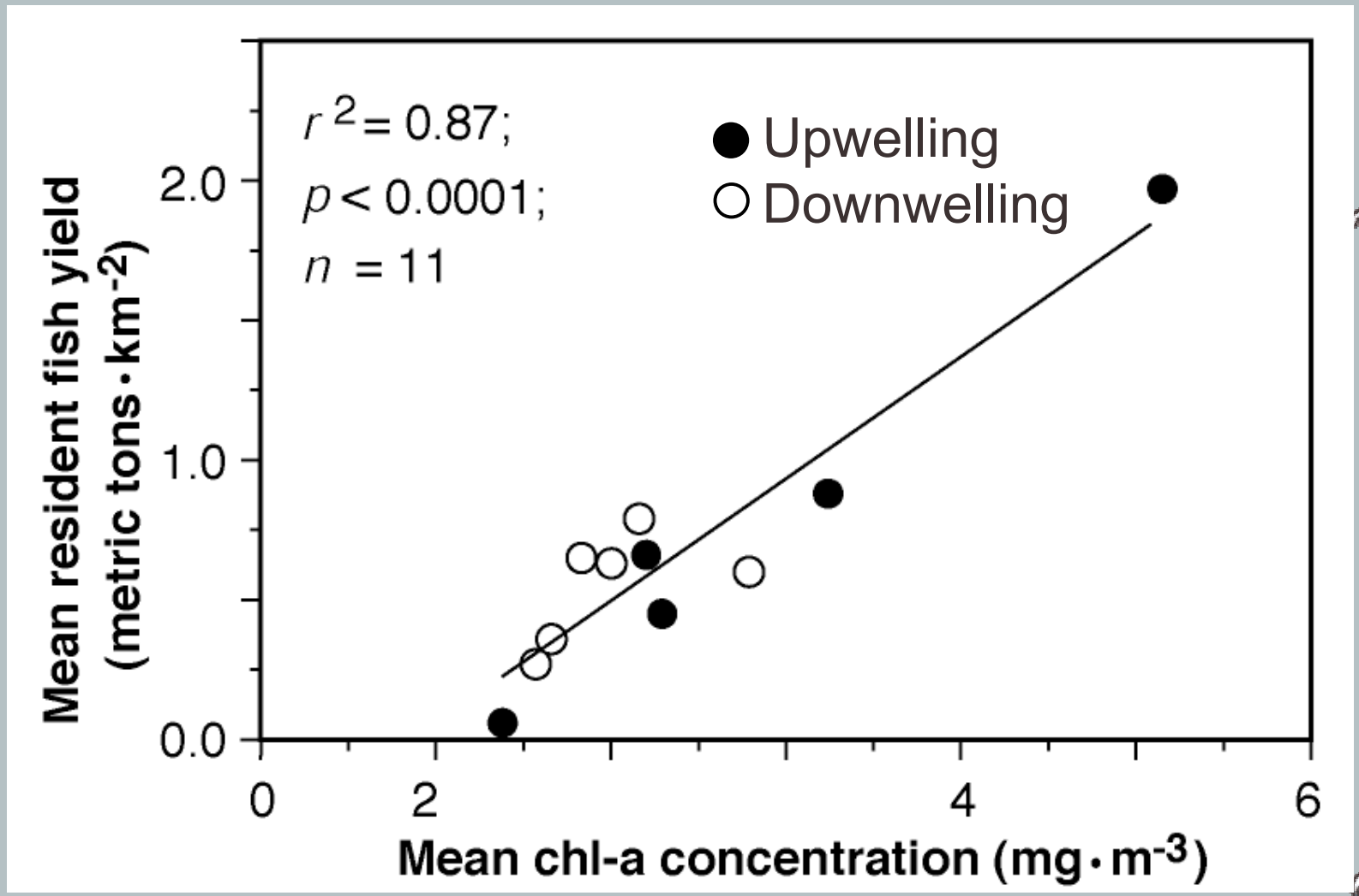
Modified from Pauly & Christensen [1993]

Linkages



Ware & Thomson [Science, 2003]

Linkages

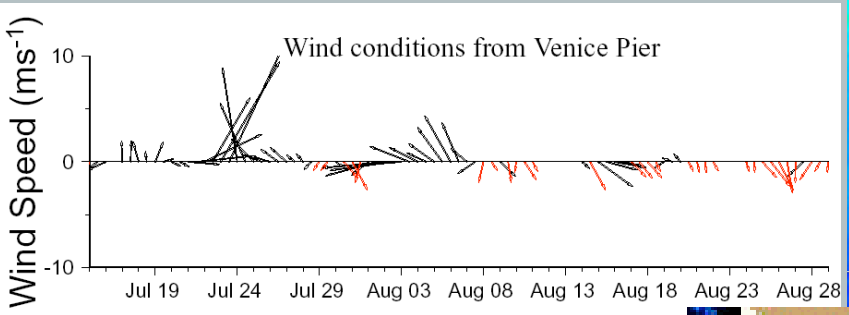


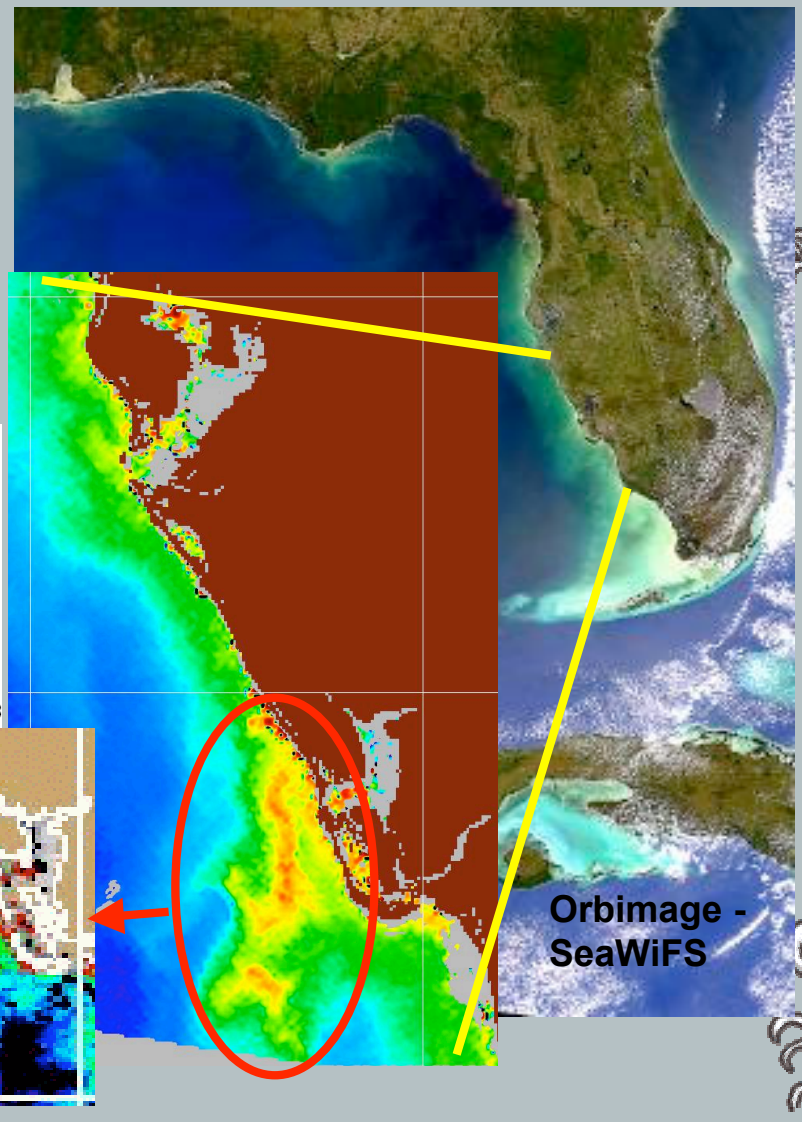
Ware & Thomson [Science, 2003]

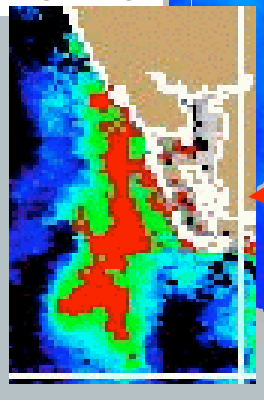
Harmful Algal Bloom (HAB) detection

NOAA National Ocean Service

Operational Monitoring and Forecasting of HABs in the Gulf of Mexico



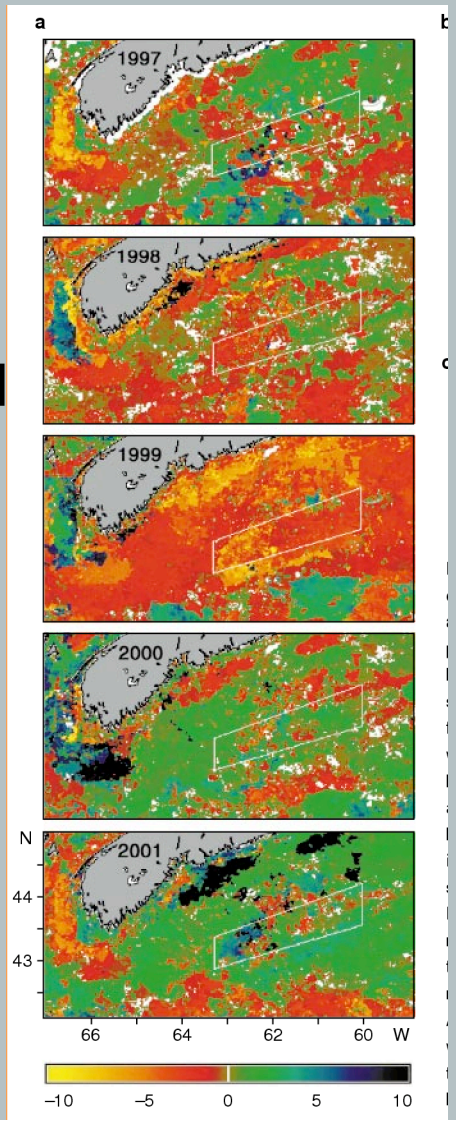


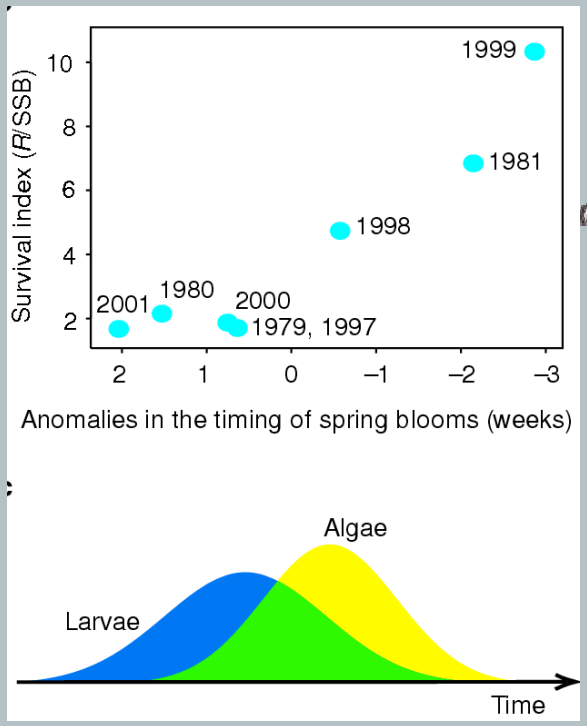


Courtesy of Rick Stumpf, NOS

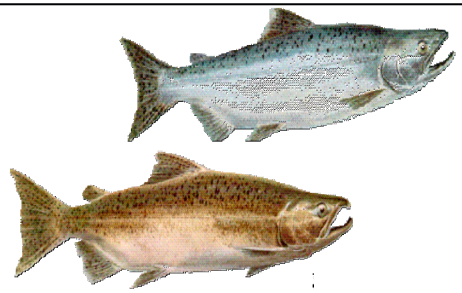
Timing of the Spring bloom and Haddock Survival

Contours of the annual anomaly in the timing of the spring bloom based on SeaWiFS chlorophyll data

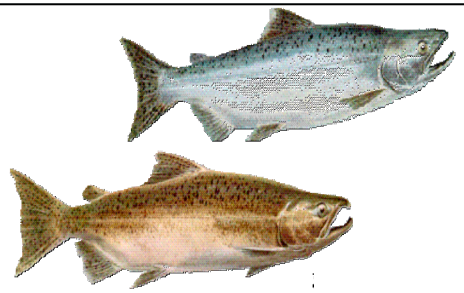




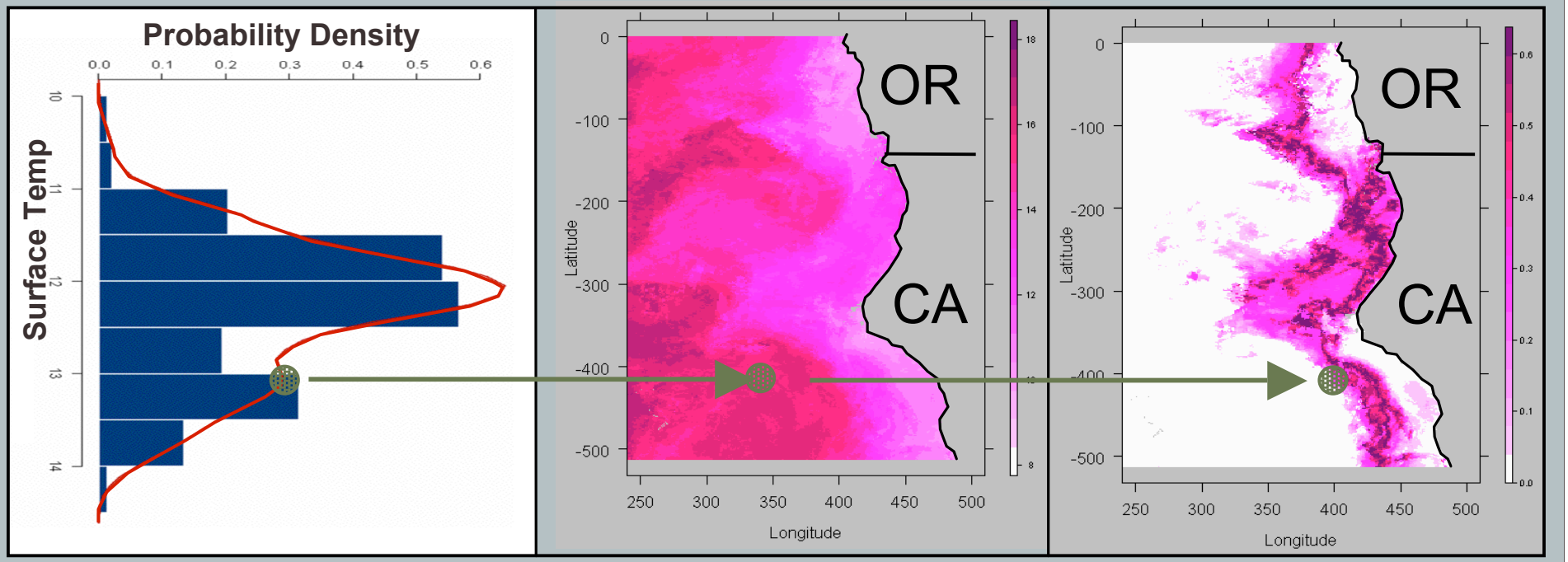
From Platt et al., Nature, 2003



Defining Salmon Ocean Habitat



Chinook Potential Habitat



Density of fish's temperature experience at the surface from tag data

Satellite SST

"Contours of utilization" – likely fish location

Hinke et al., in press, MEPS, 2005

NOAA/NMFS/SWFSC ERD

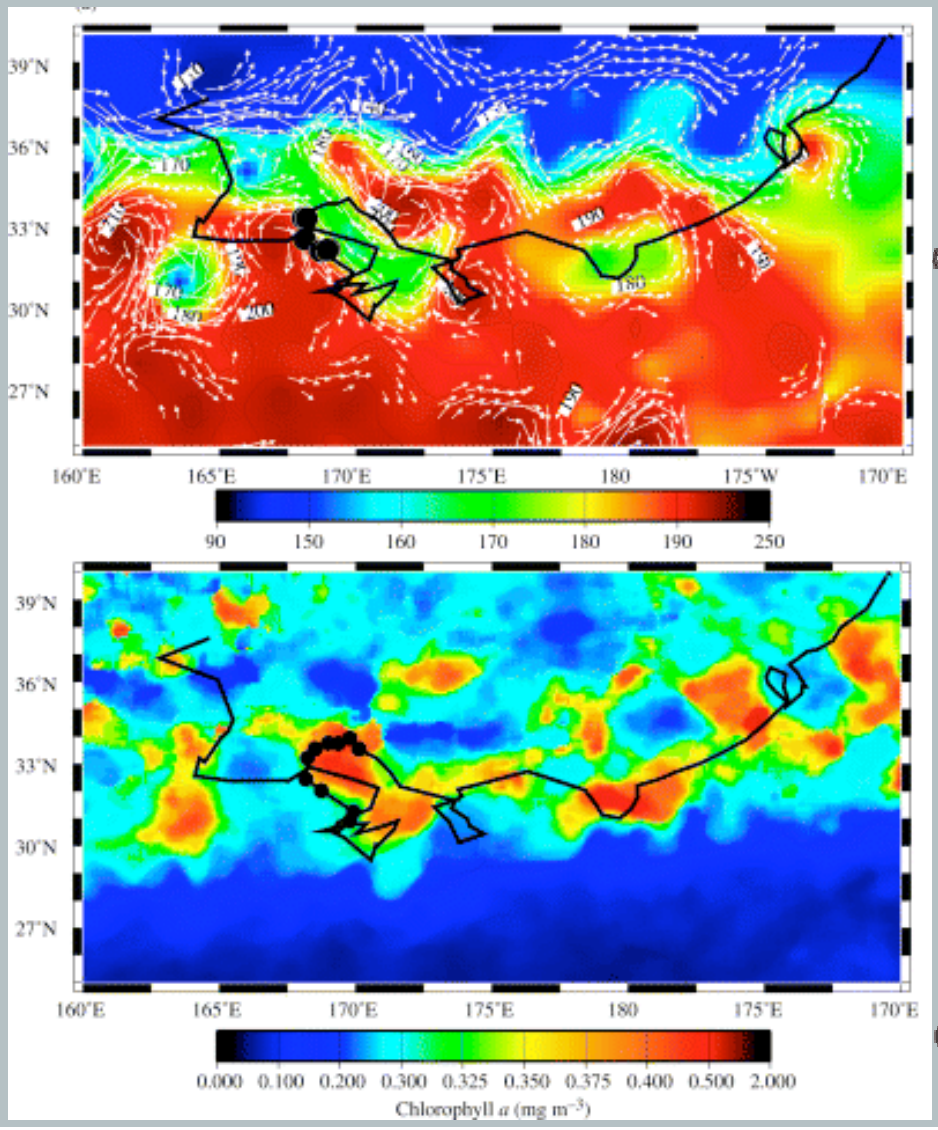
Characterizing Turtle Habitat

SSH

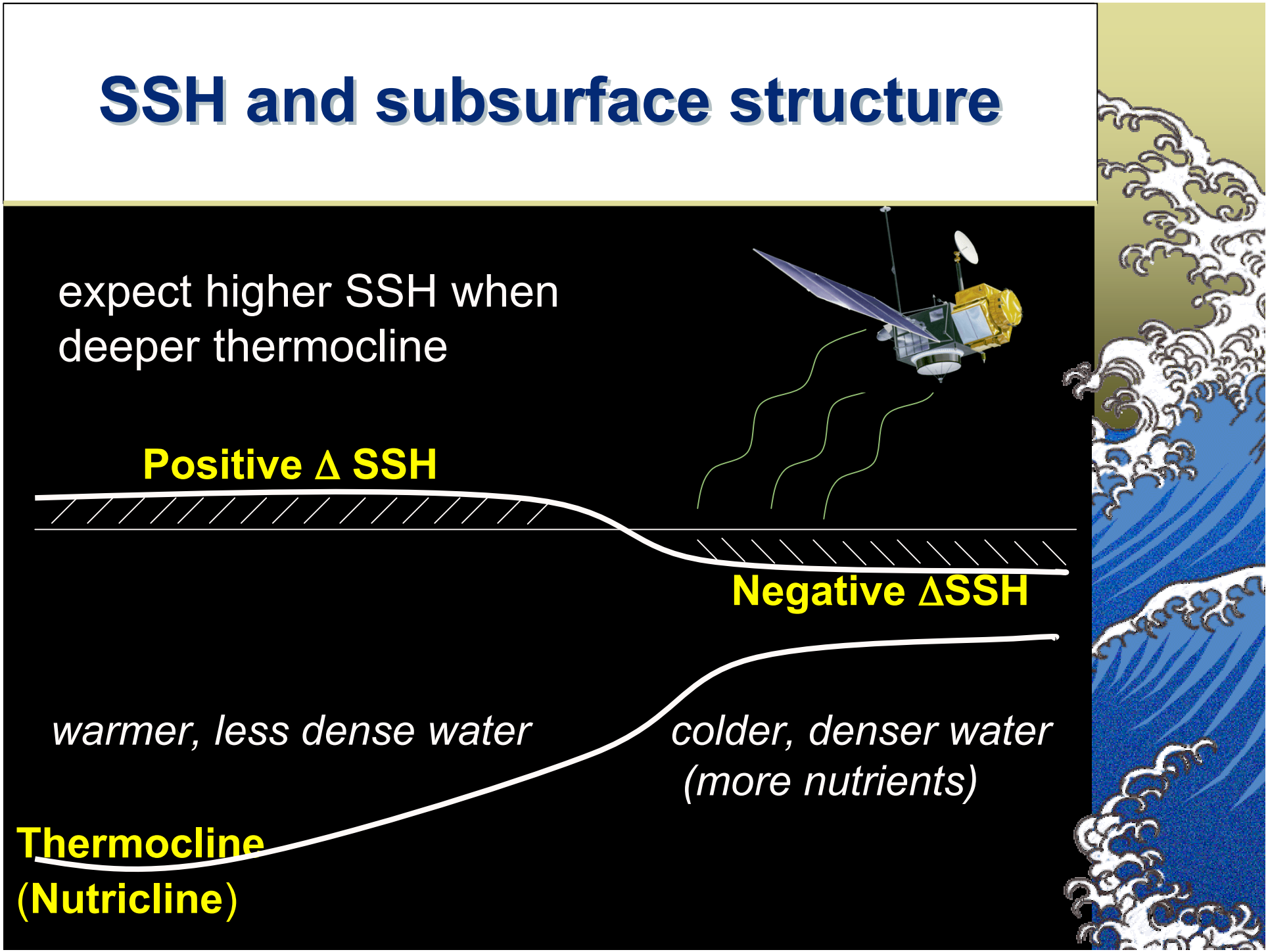
Loggerhead turtle tracks along the TZCF (Transitional Zone Chlorophyll Front) in the North Pacific during Feb. 2001

Chlorophyll

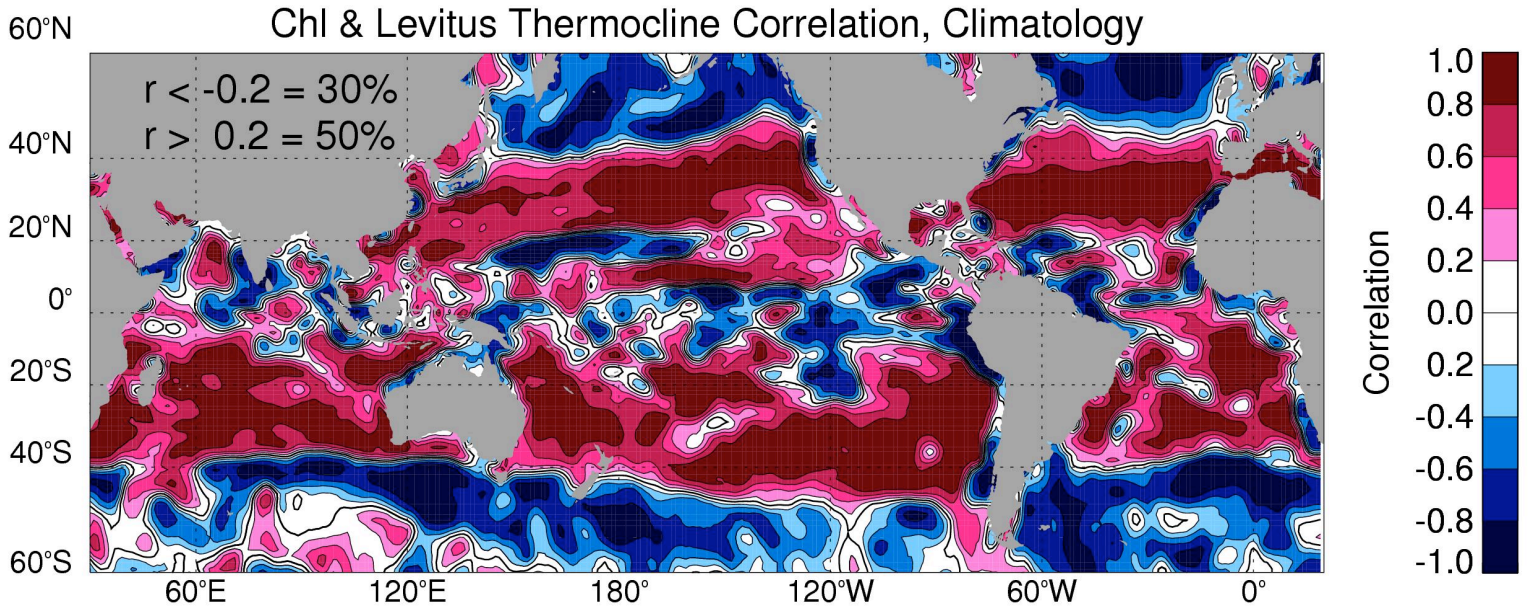
Polovina et al., Fish. Ocean., 2004
NOAA/NMFS/PIFSC



SSH and subsurface structure



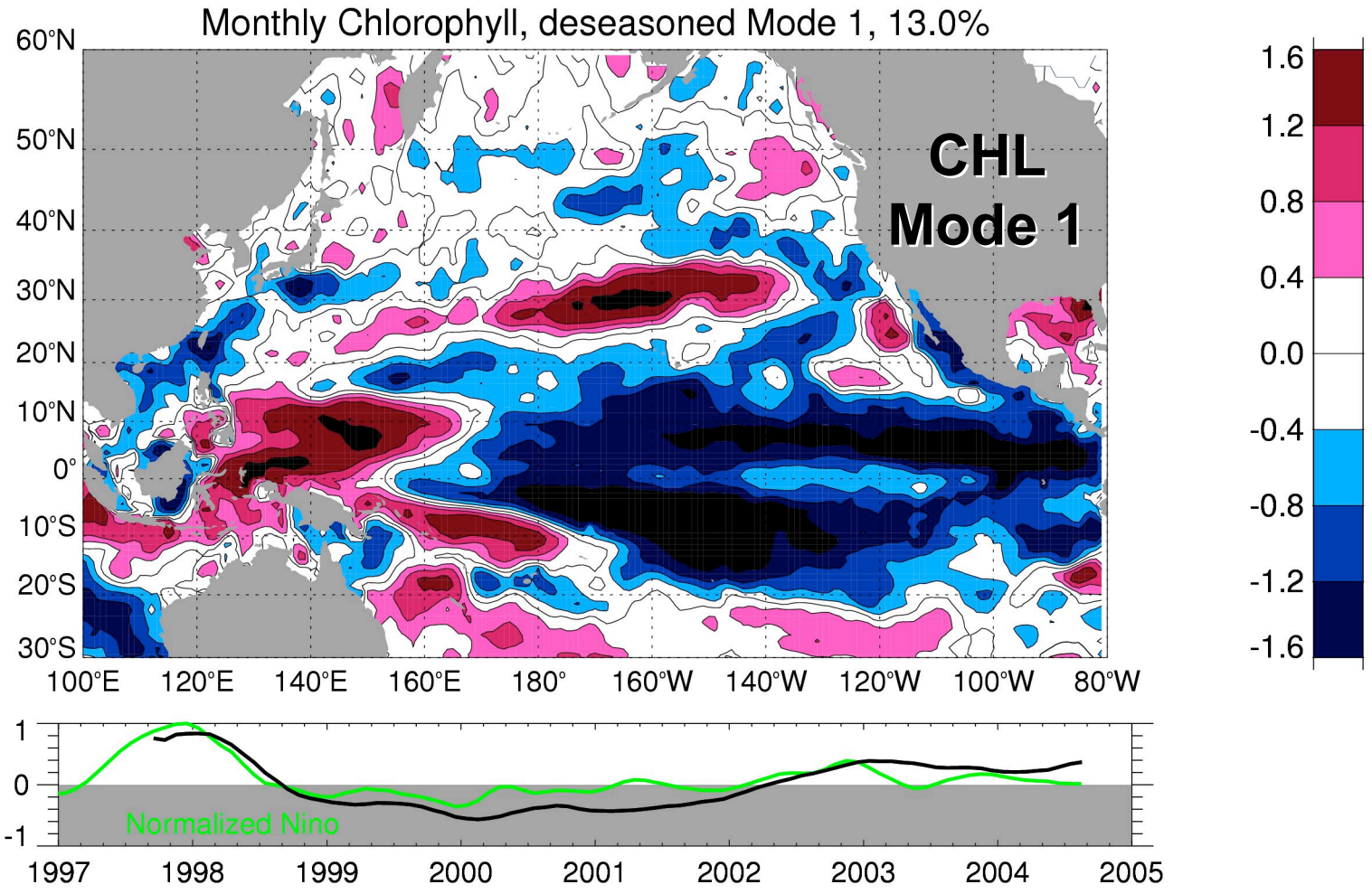
Regional differences in bio-physical dynamics



Different relationships between chlorophyll & thermocline depth between the tropics, mid-latitudes and subpolar regions.

Wilson & Coles, in press, 2005, NOAA/NMFS/SWFSC ERD

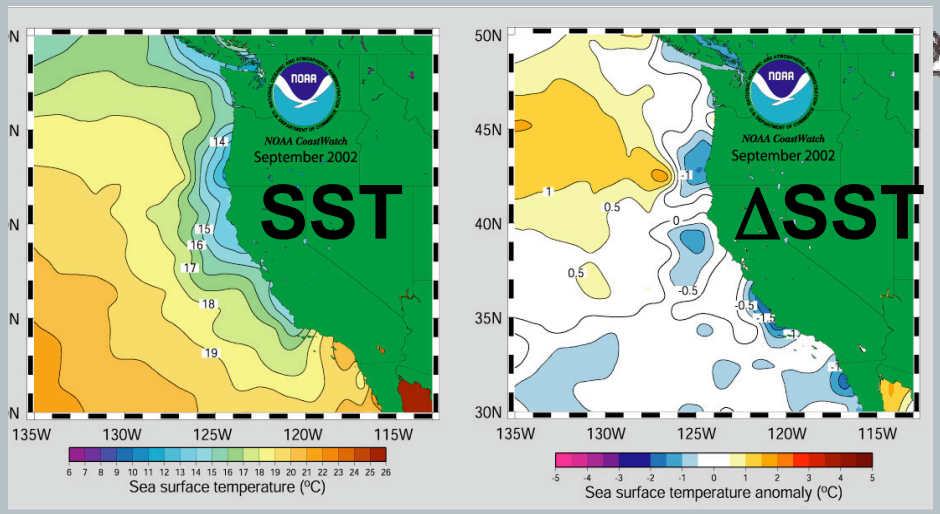
Chlorophyll Variability & El Niño



Wilson & Adamec [JGR, 2001]

El Niño Watch

- Generated monthly by NOAA's west coast CoastWatch node
- Special SST data product prepared for NMFS SWR fishery managers, mandated for use in managing CA fishery for large pelagic fishes
- First use of satellite data in management of West Coast Fisheries



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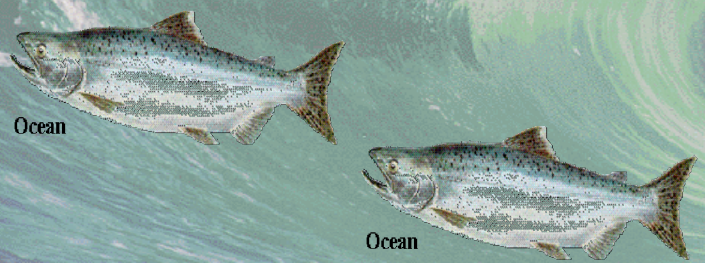
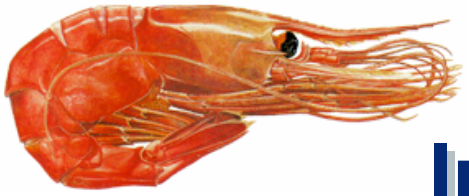
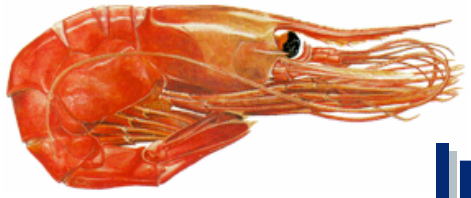




Temporal Events Important to Ecosystems

- Upwelling
- Harmful Algae Blooms (HABs)
- Oil Spills
- Seasonal Transitions
- El Niño events
- Regime Shifts (i.e. PDO)
- Global Climate Change



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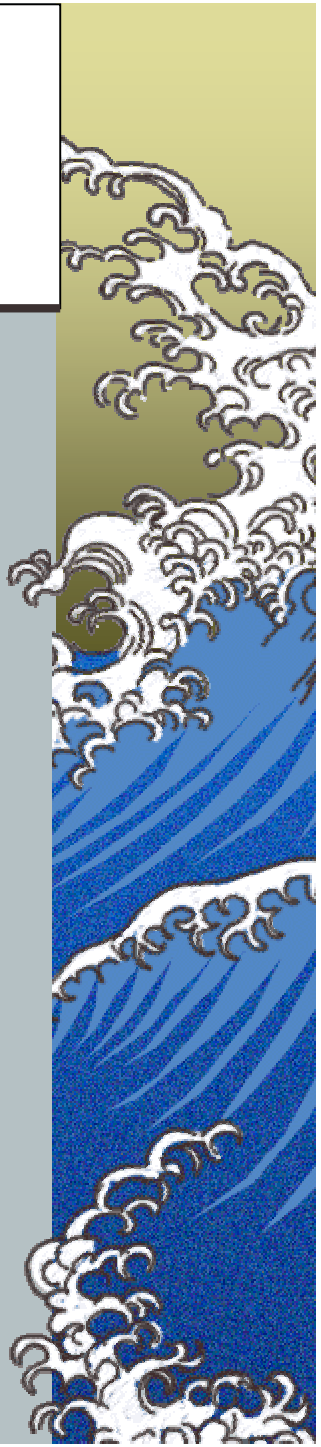


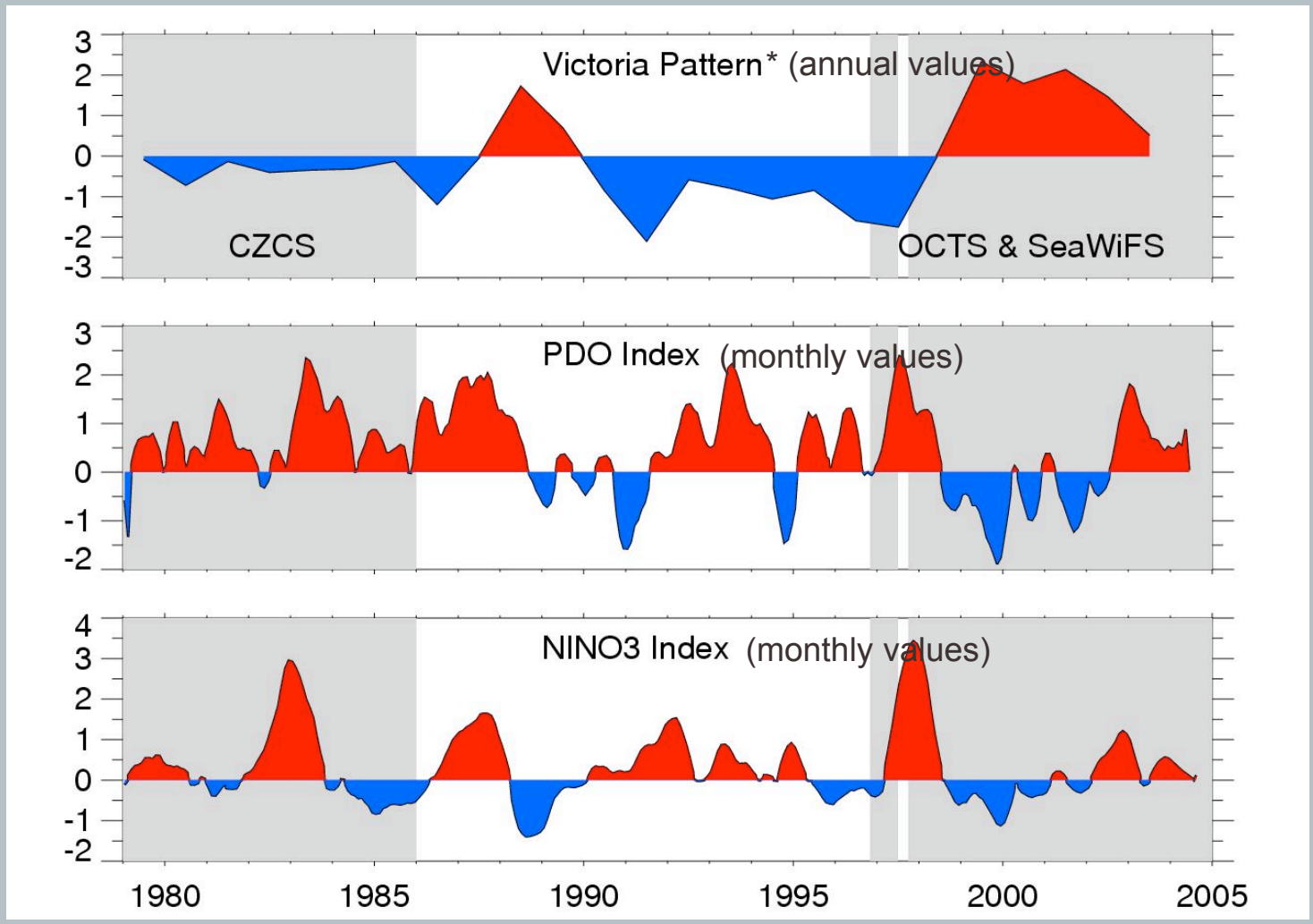
Climate Data Records (CDRs) of satellite measurements need to be maintained!

Question…

How does climate variability project onto marine ecosystems?

- Difficult to resolve because of different scales of climate data and ecosystem data
- Traditional datasets can have long time series, but sparse spatial resolution
- Satellite datasets with high temporal and spatial resolution, but existing for only relatively short timescales

Different frequencies of temporal variability



* from Bond et al. [2003]

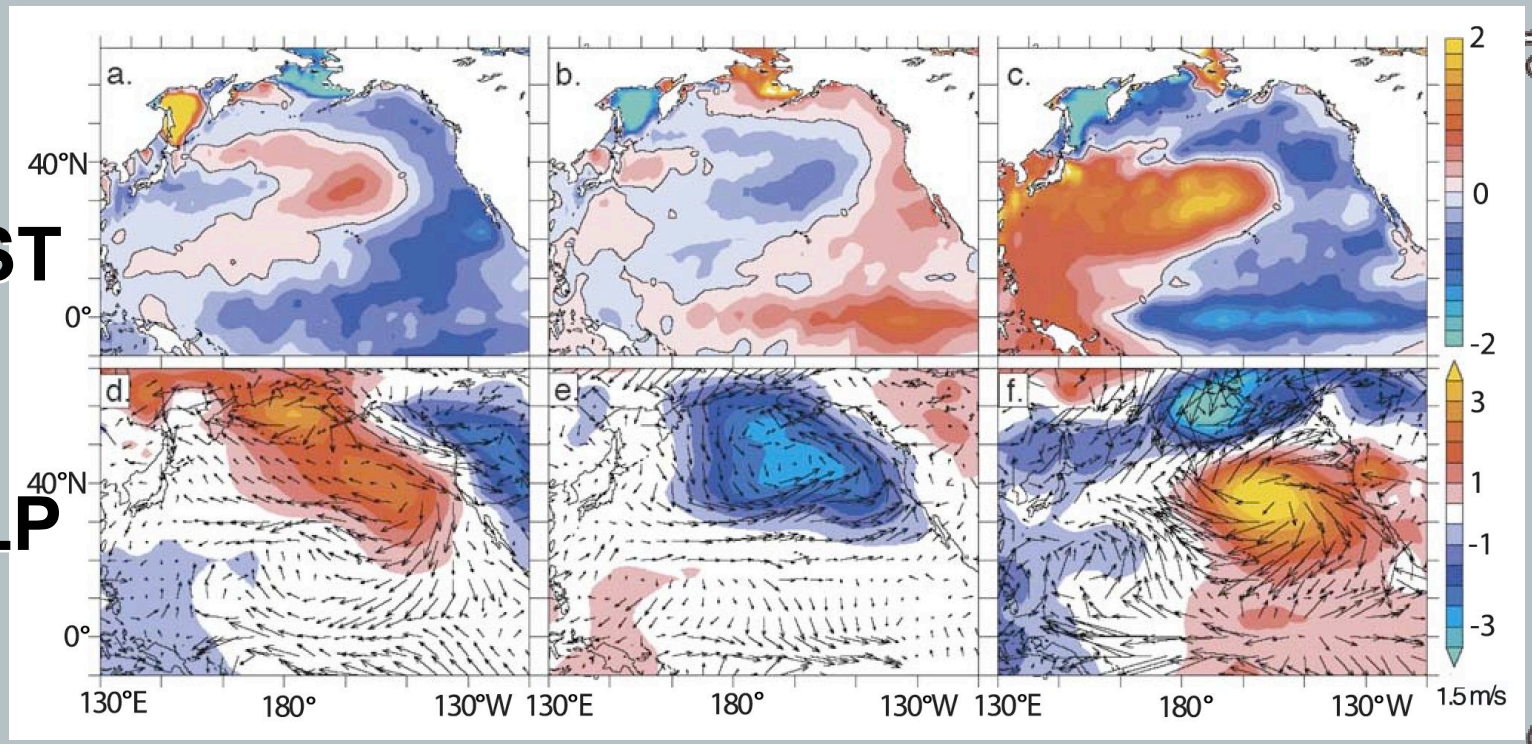
Different spatial patterns of temporal change

Cool PDO **Warm PDO** **Cool PDO**

1970-76 **1977-1983** **1999-2003**

SST

SLP



from Peterson & Schwing, GRL, 2003 NOAA/NMFS

Transition Zone Chlorophyll Front (TZCF)

The TZCF is an important migratory and foraging pathway

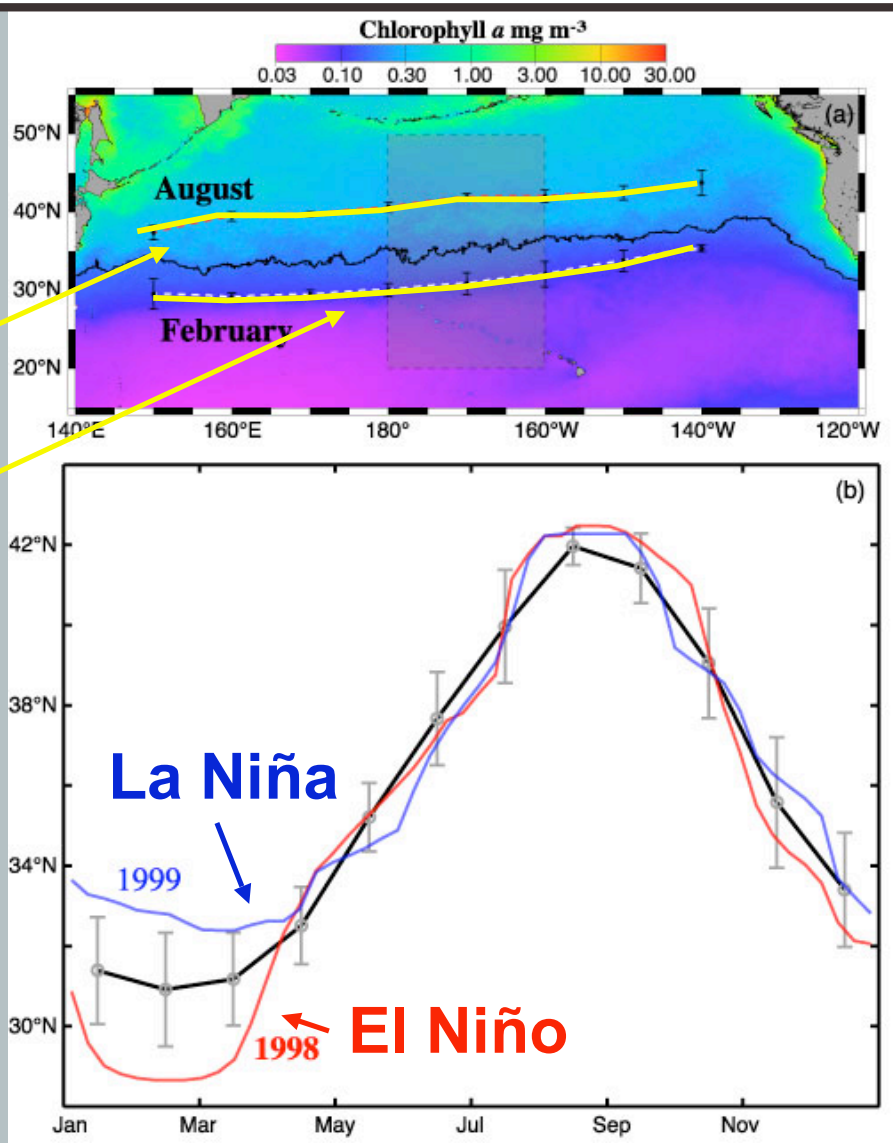
Seasonal variability

summer winter

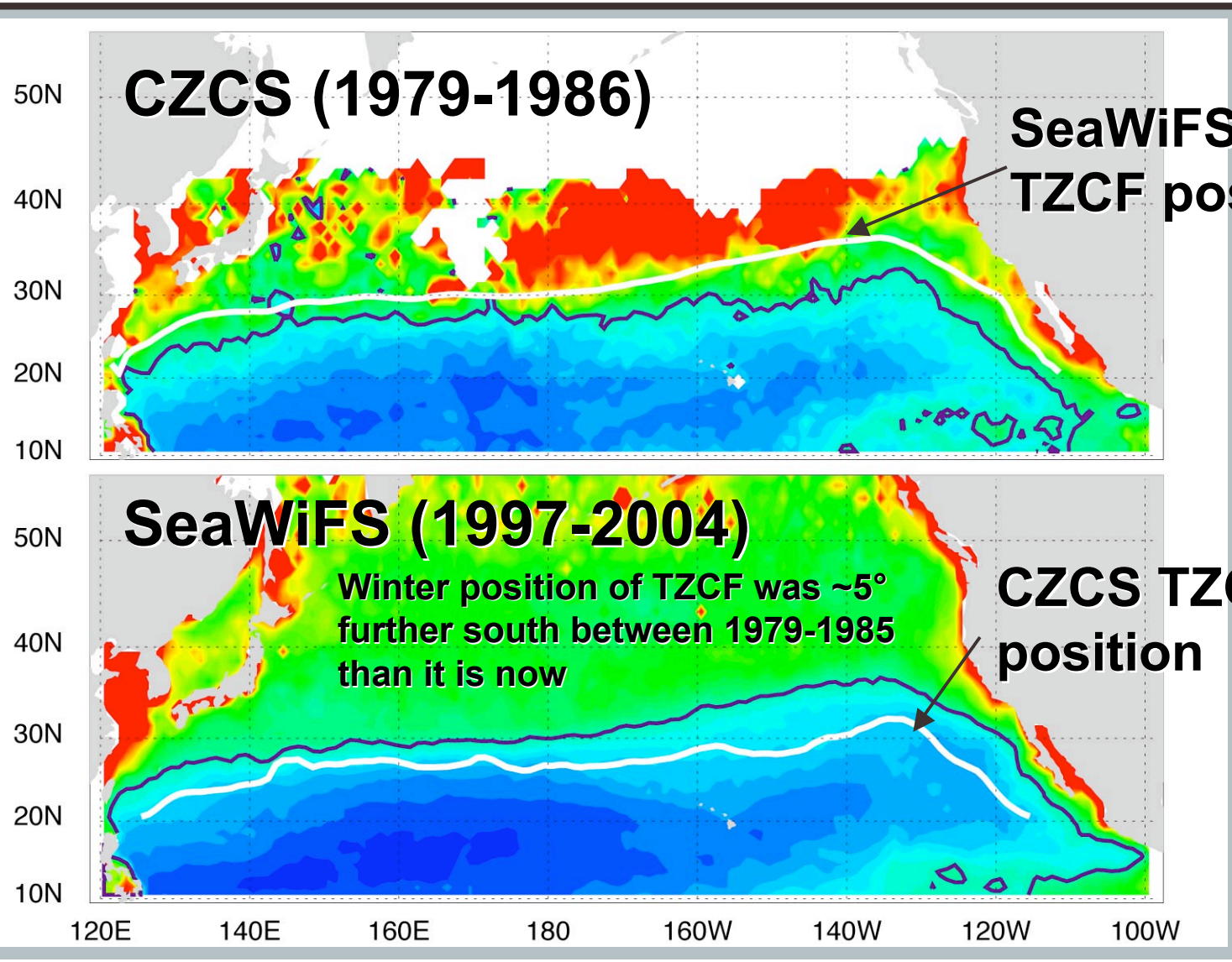
ENSO variability

Interannual variability??

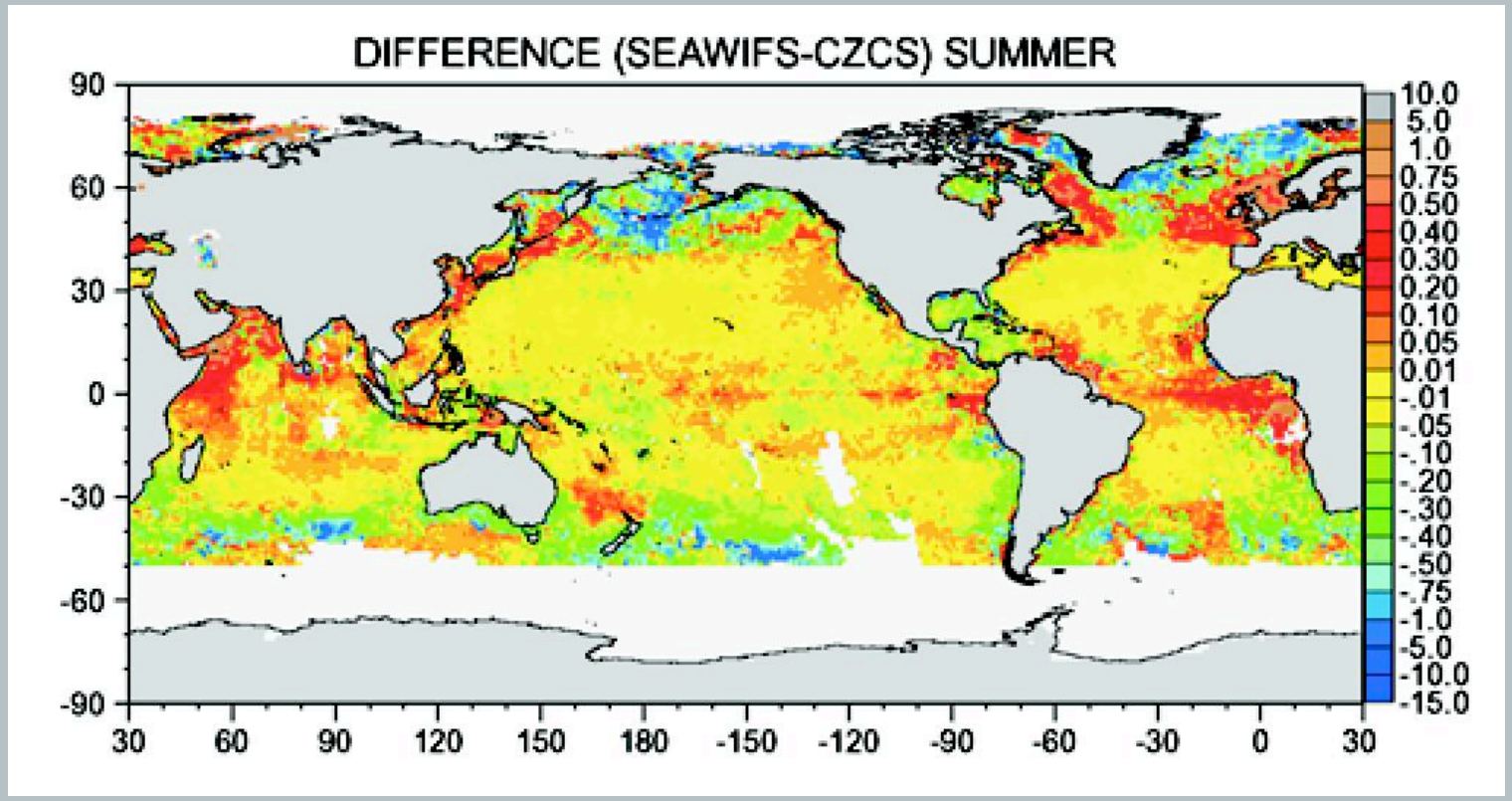
from Bograd et al., GRL, 2004



January TZCF



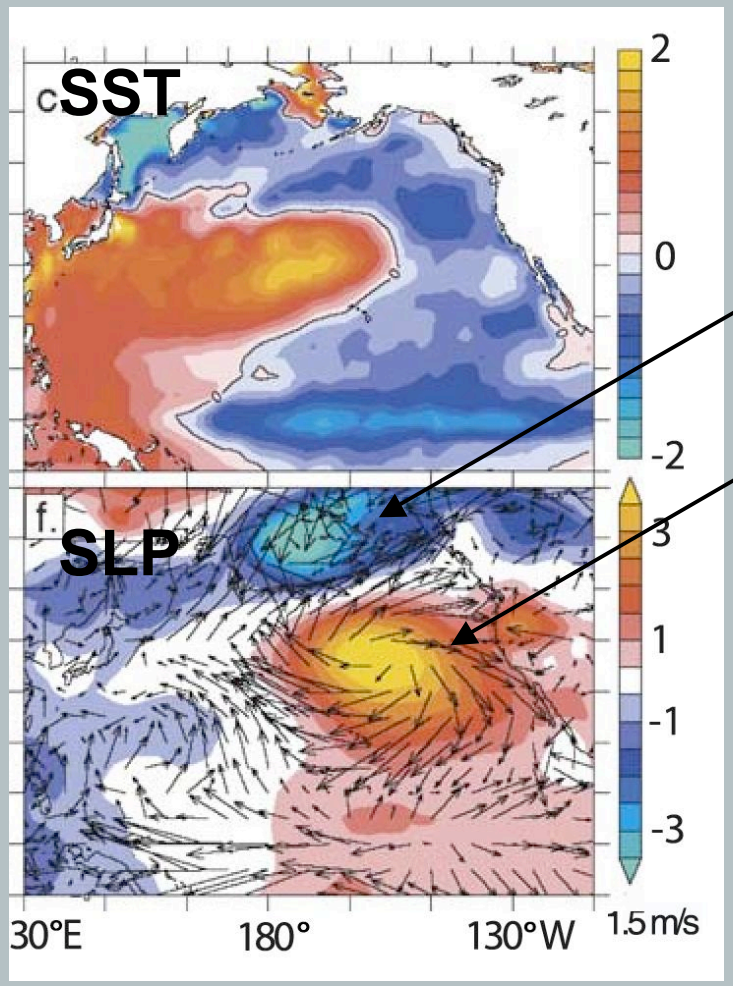
Decadal chlorophyll changes

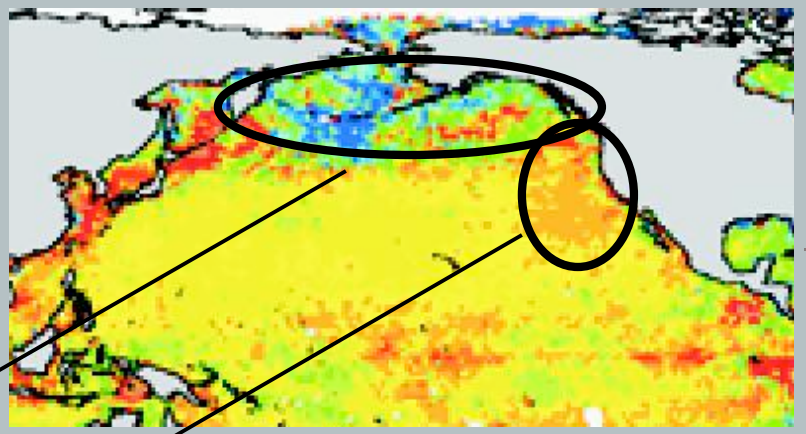


From Gregg & Conkright, GRL, 2002

Decadal Differences

1999-2003

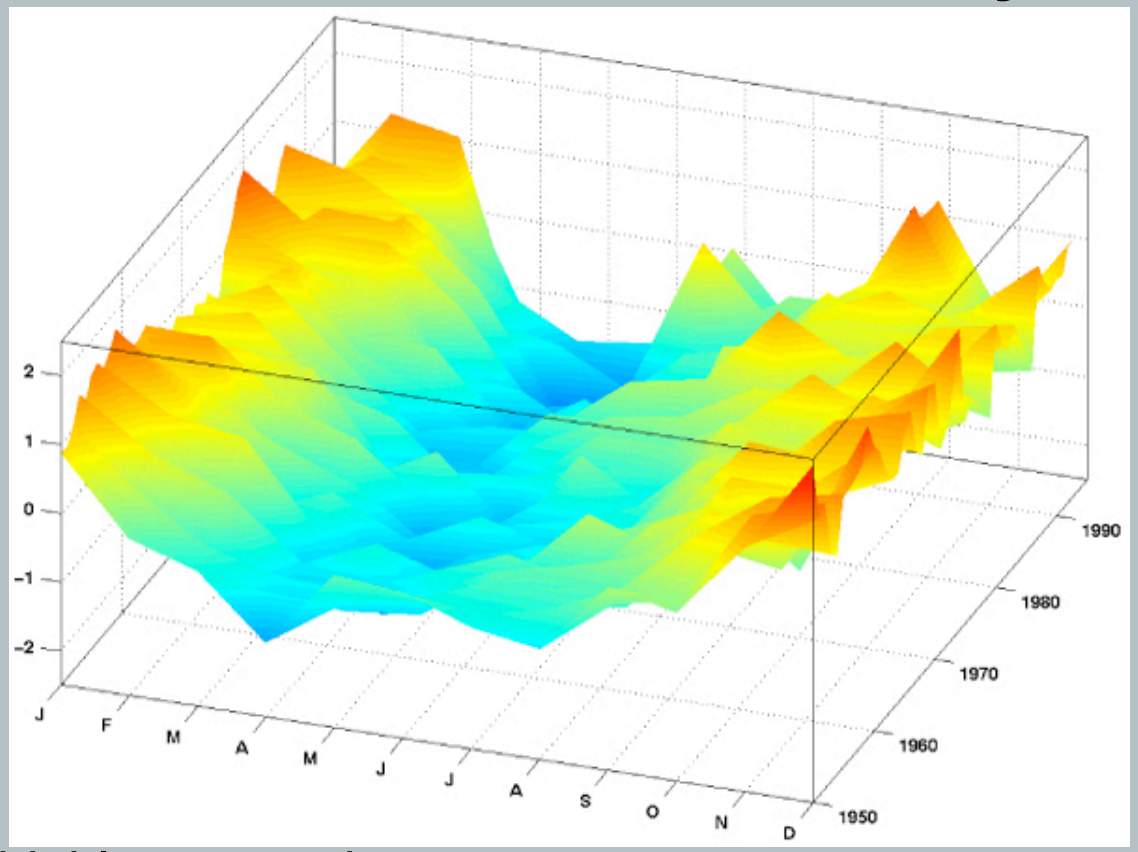




Chlorophyll
(1997/2004) - (1979/86)
Gregg & Conkright, 2002

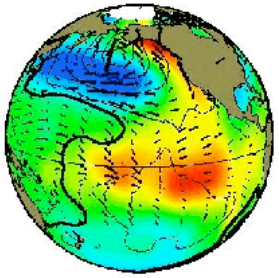
Changing Seasonality

Coastal California, Mixed Layer Temperature



Bograd et al., 2004

- highly non-stationary
- variability in amplitude, phase
- long-term changes in coastal upwelling (timing, duration, intensity)



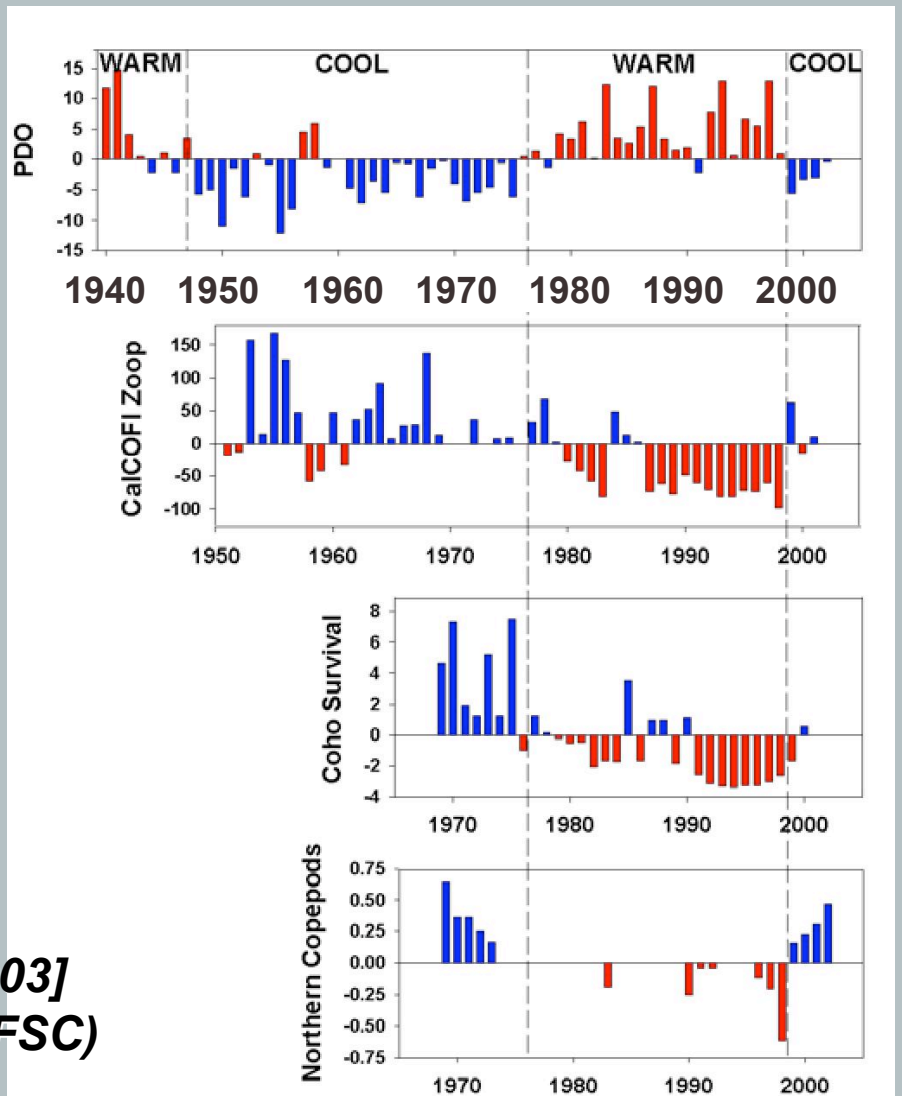
Regime shifts

PDO

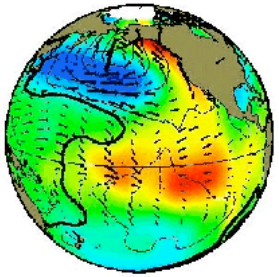
Zooplankton (CalCOFI)

Coho Survival

Copepods



Peterson & Schwing [GRL, 2003]
(NOAA/NMFS - NWFSC & SWFSC)



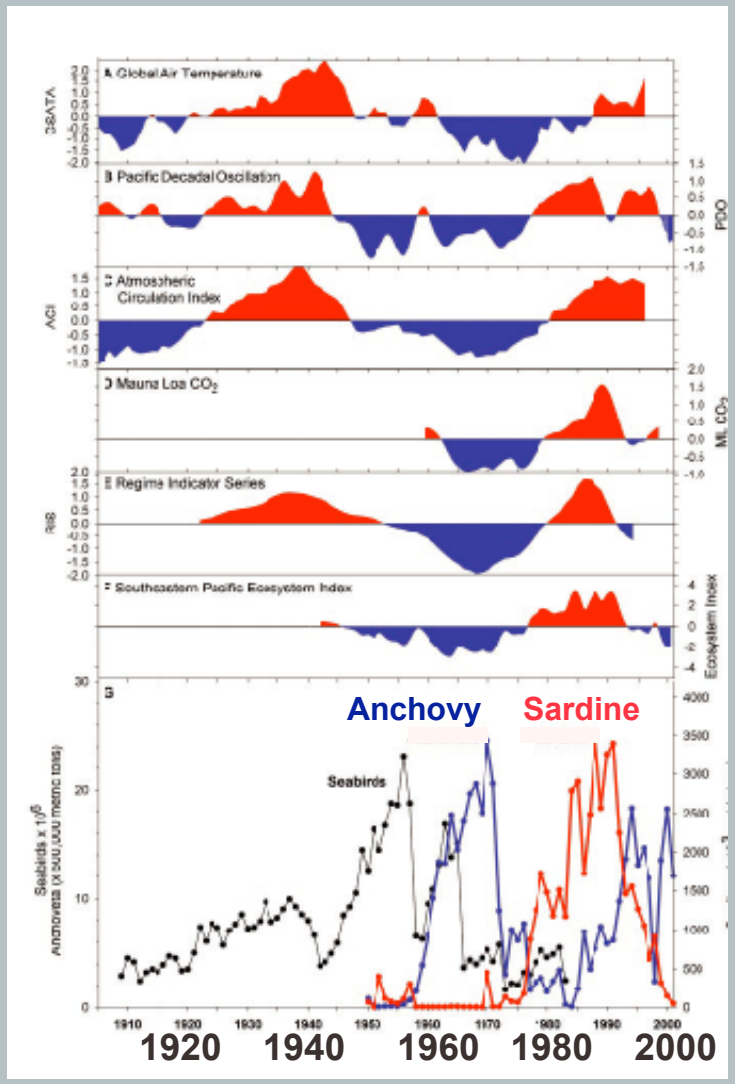
Regime shifts

Global Air Temperature

PDO

Atm. Circulation

CO2



Long-term Climate Data Records (CDRs) are essential for Fisheries needs!

Chavez et al. [Science, 2003]

Summary

- Environment satellite data (ocean color, SST, SSH, SST) is crucial for characterizing and monitoring marine ecosystems, as part of NMFS's ecosystem based approach to fisheries management.
- The high spatial and temporal resolution of satellite data, used synergistically with in-situ measurements, places them in a larger scale context.
- Maintaining CDRs (Climate Data Records) of satellite datasets is essential for understanding ecosystems and their climate related variability.